FISK (S. A.)

A STUDY OF THE CLIMATE OF COLORADO

AS APPLIED TO THE ARREST AND CURE OF PULMONARY DISEASE.

BY

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A STUDY OF THE CLIMATE OF COLORADO AS APPLIED TO THE ARREST AND CURE OF PULMONARY DISEASE.[1]

BY SAMUEL A. FISK, M.D.,
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IN the presentation of this subject I shall not attempt to argue the question of the advantages of a high altitude over those of a low, nor to extol the virtues of a cool climate as opposed to a warm, nor yet to praise dryness as contrasted with moisture. I shall accept the fact that the climate of Colorado is characterized by elevation and dryness, and it is essentially a cool climate, and on that basis will it be my endeavor to describe its several qualities, faithfully and impartially; to be eyes and ears for the reader, to be the observer in his stead, and, in so far as I am able, not only to state its good qualities, but its bad, so that I may be free from the charge, so often laid at our door, of being *ex-parte* in our writings, and of at least suppressing the truth even if we make no misstatements.

[1] Read before the American Climatological Association, Washington, 1888.

In selecting this subject for presentation, I am aware that I may lay myself open to the charge of offering nothing new; but so convinced am I of the merits of the Colorado climate, so many cures have I seen wrought in it, during my eight years of experience, and so efficacious do I believe it to be in the arrest or cure of pulmonary disease—in many of its forms—that I cannot refrain from adding my voice to those who are proclaiming its virtues, until, by sounding its praise so long and so loud, we may compel the world to hear.

"What do we mean by climate?" is the very pertinent question which Dr. Burney Yeo asks at the opening of his work on that subject; and he answers it by saying: "We generally mean by a question of this kind that we desire to know how the natural conditions and surroundings of a particular place affect the life and well-being of its human inhabitants." These conditions are the nature of its atmosphere, or aërial cloak, and the nature of its surface.

Let me speak of the latter condition first. The State of Colorado embraces a territory between seven meridians east and west, and four parallels north and south—that is, it is 380 miles long and 280 broad, having an area of 103,925 square miles, a superficies which is considerably more than double that of the State of New York, thirteen times that of Massachusetts, and twice that of England. The southern border of this tract corresponds in distance from the equator to Old Point Comfort, while its northern border equals Yonkers on the Hudson. Its

most densely inhabited portion, however, corresponds very nearly to the space between Fredericksburg on the south and Philadelphia on the north, while its principal city (Denver) has the latitude of Baltimore in this country, or of Lisbon in the old world.

It is evident that in speaking of a climate of so vast a tract of country one can only mention the prevailing characteristics, and that considerable allowance must be made for deviations from that which is accepted as the standard. Through the centre of Colorado, running north and south, the Rocky Mountain range extends, its water-shed on the east emptying into the Mississippi River, by means of two small tributaries, the south branch of the South Platte in the north and the Arkansas in the south, streams which can easily be forded, and in summer time are so shallow, especially the Platte, that one can wade them without wetting the knee. The flow from the western water-shed is into the Pacific, through the Colorado River, while to the south a small portion of the State drains into the Gulf of Mexico by means of the Rio Grande.

I have spoken of these points because I wish to emphasize the fact that the drainage of the melting snow, from the 280, or over, miles of mountain-sides, whose waters flow to the east, is mostly subterranean, and that the surface is dry, affording a very slight amount of water. This factor is of most importance as contributing to the dryness of the climate, a condition which is due in a large measure to the distance which separates the State from any

large body of water. Within the portion of Colorado lying to the east of the mountains, that portion most frequented by invalids, there are no large bodies of water from which the air can take up moisture, and a distance of over 900 miles from the Gulf, the nearest large body of water, is an additional cause for the exceeding dryness of the air of this State. Atmospheric dryness, due largely to geographical position, is one characteristic of the climate of Colorado. Of course, this condition is also affected by atmospheric pressure, elevation, and temperature; but in the main it is due, as I have said, to geographical position.

But of almost equal importance, as has been ably shown by the researches of Bowditch and Buchanan, is the question of soil dryness. Here, again, the conditions are most favorable. To the east of the mountains, the portion of the State most inhabited, the land falls in a gradual descent from an elevation of about 6000 feet at the foot-hills, to one of about 3500 feet at the eastern border of the State, some 190 miles distant. Its surface is well drained into the two rivers I have mentioned, whose waters come principally from the mountain-sides, and, as a fact, most of these waters sink into the porous and thirsty soil to increase the subterranean flow, or to well up again as they near the mouth of the streams. Besides this natural drainage, favoring soil dryness, there are the additional features of a sandy and porous soil, which absorbs moisture rapidly, the absence of shade to retain it, and the further absence of precipitation to make it moist, as I shall have occasion to show further on in this paper.

Another property possessed by this climate due to the nature of its position is elevation. This varies from 3500 feet at the eastern border of the State, to 4500 feet at Pueblo, 5200 feet at Denver, 6000 feet at Colorado Springs, 7200 feet at Idaho Springs, 8000 feet at Georgetown, and 10,000 feet at Leadville. So that it is possible, within these limits, to give a patient any degree of elevation that may seem desirable.

Further than that, local configuration varies so that one can have his choice of open plain or of mountain valley. He can have the winter on dry ground at Colorado Springs, Denver, and numerous other places; or he can enjoy what Dr. Frankland and others place so much stress upon, in considering Davos Platz—that is, the solar radiation intensified by radiation from the snow in valley and on peak, such as occurs in narrow valleys amongst the mountains. The large area of the State admits of great variety of location, which can be taken advantage of by the invalid, and which our physicians are now studying and learning more closely. The common characteristics, due to surface and position, are: elevation, soil, and atmospheric dryness, rarefied air, an absence of shade, and a temperate clime, varied somewhat from the main characteristic by conditions induced by rarefaction of the air, absence of atmospheric moisture, and a sandy soil.

Let us turn now to a consideration of the atmospheric conditions prevalent in Colorado. Here, again, I shall give the prevalent and main characteristics, and I take the privilege of presenting those

conditions that exist at Denver, for the reason that it is the centre of the State, as regards its population, and nearly so as regards its geographical position. It is the capital, the best known place in the State, and, further, meteorological records have been kept in it for the last dozen years.

The facts that I shall now proceed to give, I have taken largely from these records; I shall refrain, however, from giving tables, because they are wearisome, and must refer you to the writings on this subject

"The chief conditions of the atmosphere," says Yeo, "that affect the climate of a place, are these: (1) its temperature; (2) its movements (winds); (3) its amount of aqueous vapor; (4) its electrical conditions; (5) its purity; and (6) its density or pressure."

Dr. Frankland, in his article—"A Great American Winter Sanitarium for the American Continent," states as the qualities of climate existing at Davos Platz, which he regards so desirable: (1) great elevation above sea-level; (2) a continuous and, during winter, permanent snow-covering; (3) a minimum of watery vapor in the air; (4) a clear sun; (5) a clear atmosphere, free from zymotic germs, dust, and fog; (6) a sheltered position favorable for receiving both the direct and reflected solar rays. These views are sanctioned by Hermann Weber, Lindsay, Yeo, Tucker Wise, and others. Some places emphasize upon the presence of ozone; but as so little is known positively about ozone and about electrical conditions of the atmosphere, I think that we may dispense with any consideration of them, simply ex-

pressing the belief that whatever advantages come from their presence are common to Colorado with other high altitude resorts.

Taking, then, the gauge of the climate as set down by these eminent authorities, let me show to what extent they exist in Colorado, and how they are considered to be beneficial.

Elevation, or diminished atmospheric pressure, is presumed to induce a more rapid circulation, which may, in many cases, be beneficial by assisting the removal of the products of disease in the chest. On the other hand, in greatly enfeebled cases, it may so hasten metabolic change as to be highly injurious.

It also increases the number and depth of the respirations, a condition of affairs which is assumed by many to be due to the fact that the diminished oxygen in the rarefied air causes a so-called "starvation of oxygen," which requires a hastening of the respirations to supply the deficiency—a theory which Dr. Hermann Weber pooh-poohs, and which seems but little susceptible of mathematical demonstration. The increase in the number of pulse-beats and of the respirations, I think, tends to regulate itself after a residence in high altitudes. Authorities agree, however, that chest expansion does occur, and this may be beneficial as calling into play unused, or but feebly used, portions of the lung.

Beneke has shown that heat is lost from the self-same apparatus more slowly on the tops of mountains than at the seashore, a fact which Frankland emphasizes with reference to the sensation of cold, when he says, "The air, if still, feels warmer at an

elevated station than in the lower and denser regions of the atmosphere, in consequence of the slower abstraction of heat from the body."

Hermann Weber speaks of the fact, that at elevated regions blood flows to the surface of the skin, that it thus becomes better nourished, that internal organs become unloaded, and that the elimination of carbonic acid from the blood of the lungs is facilitated.

Whatever benefits come to the human economy from a residence at high altitude, and I have mentioned some that are presumed to accrue, they are to be gained by living in Colorado, where the elevation of the inhabited portion of the State ranges from 3500 to 10,000 feet.

Humidity.—This element is highly variable in mountain resorts; it depends on the character and direction of the prevailing wind, and on the local configuration; the tendency, however, is toward dryness rather than humidity. I have already shown how the geographical position and configuration of the surface of Colorado tend to the production of atmospheric dryness; of course, the rarefaction of the air aids in the same direction. But now let me state the facts:

The average mean relative humidity for a series of years I have calculated to be only 45.8 per cent. of saturation, as against 69 per cent. in Jacksonville, Florida; 70.2 per cent. in New York; and 65.8 per cent. in Los Angeles, California. I have also shown, in a previous writing, that this mean is reduced to an average mean of 41.5 per cent. at noonday for the eight winter months of September to April in-

clusive, and that it not infrequently sinks to 25 per cent. of saturation; a condition that in Switzerland would endanger the production of the Föhn.[1] If, instead of relative humidity we speak of absolute humidity—*i. e.*, the number of grains of vapor contained in a cubic foot of air—the showing is immensely in favor of Colorado, inasmuch as rare air at a given temperature will hold less moisture than a denser air at the same temperature. The mean absolute humidity for Denver for a series of years was only 1.81 grains of vapor, as against 5.38 grains at Jacksonville; 3 02 at New York; and 3.77 at Los Angeles.

All authors attest the value of dry air in the arrest or care of pulmonary disease, and the influence of moisture in its production. A patient in search of a dry air cannot do better anywhere in the United States than to come to Colorado.

Sunshine.—It is in this particular that the Colorado climate is particularly strong. Figures show that, according to the signal service method of reckoning cloudy days, there are only 46 such in a year in Denver, as against 87 in Jacksonville; 109 in New York; and 51 in Los Angeles. This, however, takes into consideration the whole twenty-four hours. If we approach the subject in another way, with reference to the ability of a patient to be out-of-doors during the daytime, we may take as a gauge what occurred in the winter of 1884–85, considering the months of September to April inclusive, in which time I find that there were only eleven days, out of

[1] A humid south wind on the Swiss lakes.

two hundred and forty-two, which were cloudy all day long—that is, when the sun did not shine at all from 9 A.M. to 5 P.M.

Certainly a counting of three hundred and twenty days of clear or fair weather in a year, when the whole twenty-four hours is considered; or of two hundred and thirty-one days out of two hundred and forty-two days, taking the hours from 9 A.M. to 5 P.M., is a tremendous showing of the extent of sunshine that occurs in Colorado,

But this is not all. The principal resorts lying, as they do, on the edge of the plains, and not being sheltered by mountains, enjoy a number of hours of sunshine a day such as few mountain resorts can boast. A comparison will make this clearer. Dr. Tucker Wise has stated that on the first day of January the number of hours between sunrise and sunset in the Alpine resorts are as follows:

	Hours.	Minutes.
Maloja	7	10
Wiesen	6	10
Pontresina	6	40
St. Moritz	5	5
Davos Platz	4	57
Andermatt	3	30

By way of comparison I introduce Denver, nine hours and seven minutes, or nearly twice that of the world-renowned Davos.

Not only does Denver enjoy so many hours of sunshine, but there is the additional consideration that the sun is up, warming the air, a number of hours before the invalid gets out-of-doors, while at Davos and other Alpine resorts the sun and the

invalid make their appearance together. The following figures of sunrise will show this; Maloja, 9.25 A.M.; Wiesen, 10.35; Pontresina, 8.30; St. Moritz, 10; Davos Platz, 10.03; Andermatt, 11.45; Denver, 7.30, for the first day of January.

Knowing the warming influence of solar radiation, the part that these early hours of sunshine play in making the air comfortable for the invalid cannot be overestimated. It is like having a fire built in a cold room an hour or two before a patient arises, or having it lighted just as he tumbles out of bed.

One more influence of sunshine, and I will then proceed to other topics. The mental influence, the cheer which bright sunshine, clear, warm air, and a dry soil give to a life out-of-doors, thereby *inviting* and not forcing the invalid to a drive, a walk, a ride, a game of tennis, and to all healthful out-of-door influences. I cannot lay too much stress upon this factor of Colorado sunshine—an important, if not the most important, feature of our climate. I would like to touch on it from the more poetic side, telling of the color it gives to daily life, but I must hasten to other considerations.

Temperature.—The question of the temperature of the Colorado climate is one of the most difficult to treat, because it involves a consideration of the difference between day and night, between the sun and the shade, between mountain and plain, between month and month. Broadly speaking, the days of the summer months are uncomfortably hot, in the cities, but even then the nights are cool, generally

requiring that one be covered with a blanket, so as to be comfortable.

There is no denying the fact that Denver and even Colorado Springs were intolerably hot this past summer. Even admitting this, the advocates of this climate can respond that the invalid should go to the mountains, where in Estes Park, Manitou Park, Georgetown, Poncha Springs, Twin Lakes, and other places, he can breathe the purest air and have comfort. But the main consideration is one of the winter months, say from September to April inclusive. Here, again, I must admit many of the adverse criticisms made in regard to our climate. One writer, hunting the records over, for years, accuses us of having a diurnal change of eighty degrees in twenty-four hours, and he was correct, such a variance does occur—occasionally.

The meteorological conditions producing this change involve so well known a principle that it scarcely seems worth while to discuss them. Land radiates heat more rapidly than water, it becomes heated and loses its heat much sooner than water; and a dry, sandy soil will do this more rapidly than a moist. Shade and vegetation hinder both processes, so that the absence of shade favors both the heating and the cooling process. A rare, dry air favors the transmission of solar heat, by robbing it of but little of its intensity, and it also aids and abets terrestrial radiation.

These, then, are the conditions existing in Colorado: a dry, sandy soil; a lack of shade and vegetation; a rare, dry air. The result is a rapid warming

up under the influence of the sun; a rapid cooling when that influence is removed. Hence we do have warm temperatures by day, and cool temperatures by night, and the difference does, at rare times, amount to eighty degrees. But, for the purposes of an invalid, the warmth and not the cold should be considered, because the latter comes at night when the invalid should be housed and can regulate the temperature, while the former is at mid-day when he is getting his exercise out-of-doors. A temperature of 62° at noon is of more importance to him than one of minus 18° at midnight. But Colorado climate is, in winter, a cool climate. The monthly mean for

January, 1886, at 1 P.M. was . . .	27.3°
February, " " " " . . .	48.0°
March, " " " " . . .	41.1°
April, " " " " . . .	52.3°
May, " " " " . . .	74.3°
June, " " " " . . .	75.1°
July, " " " " . . .	85.2°
August, " " " " . . .	81.5°
September, " " " " . . .	72.0°
October, " " " " . . .	64.2°
November, " " " " . . .	41.3°
December, " " " " . . .	45.5°

This is the temperature of the air at the time of day when an invalid is most likely to be out of doors. If these means seem too cold to the student of climate, I can only urge in extenuation: (1) To quote from Dr. Hermann Weber: "It is only a remnant of our old prejudice which can make us afraid of

dry, calm, moderate cold;" or (2) as pointed out by Dr. Frankland, and as every person who has had experience knows, that "the air, if still, feels warmer at an elevated station than in the lower and denser regions of the atmosphere;" and (3) that the solar radiation must be taken into consideration, which transforms, to one in the sunshine, the air temperature from one of 27.3° F. at noon in January, to 92.5°; or the air temperature of 45.5°, in December, to the heat in the sun's rays of 100.2°.

No one, I think, need be apprehensive of cold days in Colorado, unless he be so much impoverished in physical condition as to make him an unfit subject for our climate. In most cases the inhalation of dry, cold air stimulates the respiratory functions to greater activity, leading, as Dr. Weber asserts, to greater expansion of the lungs and thorax, to improvement of the appetite and nutrition, thus exercising a beneficial influence on the course of phthisis.

Winds.—Statistics show that the average daily movement of the air in Denver is 145 miles as against 238 miles in Boston, 207 in New York, and 159 in Jacksonville; the data further prove that at 9 A.M. the average hourly velocity is 6.7 miles during the eight months, September to April inclusive, 8 miles at 1 P.M., and 8.6 miles at 5 P.M. Despite this low average, we are constantly accused of having high winds, and of the dust and sand storms being so disagreeable as to be detrimental to an invalid. With a view of meeting this criticism I collected data, awhile ago, which showed that in the year 1886 there were only twenty-three days in which

there occurred a wind of eighteen miles or over, at two consecutive observations of the three 9 A.M. and 1 and 5 P.M., and that there were about an equal number of times when there was a wind of equal velocity at only one of these three observations. Now, a wind of eighteen miles velocity is not a high wind. It is less than double the average velocity of the air in Boston, and is not more than a stiff breeze.

We do have occasional high winds, and they occur more frequently in some places than in others, but we are not entitled to the reproach so frequently hurled at us, that the winds and dust storms spoil the climate. The truth is, that owing to the sandy character of the soil and the absence of snow covering, a wind of moderate velocity will lick up the dust and set it a flying, while a stronger wind, as of eighteen miles per hour, will set up what is called a dust storm. These are no more disagreeable than I have witnessed on Commonwealth Avenue, in Boston, many and many a time. From the nature of things they are more frequent in the narrow streets of Denver than in the open country, or in the health resorts, and are in no way to be ranked with the cyclones of Kansas, or even with the gentle and moderate breezes of the peaceful Connecticut Valley, which I have known to blow over bridges and tear up hundreds of elm trees by the roots.

These dust storms are disagreeable, principally so in Denver, where the streets are the natural soil, which becomes dried by the ardent rays of the sun and pulverized by travel, so that they have to be constantly watered, even in January and February.

But the frequency and violence of these storms have been very much overstated, and they do not seriously impair the invalid's comfort, or keep him indoors much of the time.

Precipitation.—The average yearly fall of rain and snow (melted) is 14.77 inches as against 55.94 in Jacksonville; 49.47 in Boston; 42 7 in New York; and 18.97 in Los Angeles, and of these 14.77 inches the greater part falls in the spring and summer months. Snow does not lie upon the ground in winter, and when it falls it is rapidly licked up by the dry breezes or drunk up by the porous soil.

Drs. Frankland and Weber consider a snow covering in winter of advantage because it keeps down germs, and also because, by reflecting the sun's rays, it increases the solar radiation. The former reason may be a valid one, but is it not counterbalanced by the deleterious effects of the thaw and by the decomposition and decay that are then induced? Is it not also more than counterbalanced by the disadvantage that a heavy covering of snow and ice is to the invalid who wants to drive, ride, play tennis, walk, climb, and lead an out-of-door life from nine o'clock in the morning until five o'clock at night? We in Colorado think so, and we prefer free and untrammelled locomotion on dry soil, even though there may be a few germs afloat, to wet feet, cold, hampered exercise, thaw, and everything that must follow up the existence of a deep snow covering.

As regards solar radiation, I have previously shown that while the mean average in the Maloja for November, December, January, and February was 103.75°,

that in Denver it was 99.75° for the same time, a difference of four degrees in favor of snow covering, but not of material difference when one considers the actual temperature. If an invalid is not comfortably warm in a sun temperature of 99.75°, it is to be doubted very much whether 103.75° will warm his thinned blood.

Fogs.—Almost unknown. In the winter of 1884-1885 there is not a record of a single fog from the 1st of September to the 1st of May.

Purity of the Air.—I have left a consideration of this factor to the very end, because I wish to bring out certain points in connection with it. Generally speaking, every one acknowledges the purity of mountain and of sea air. We are in the habit of saying that it contains more ozone—a factor of which we do not know much. Basing our ideas upon the investigations of Pasteur, Tyndall, and Miquel, we say it is aseptic, free from germs, and we place the limit of germ-life at elevations ranging from 5000 to 7000 feet. I wish to raise the question whether we are right in so doing, and whether this principle may not be varied by other influences, so that instead of being taught to believe that altitude, in itself, is a germicide, we shall not rather believe with Hermann Weber, "That wherever a large number of human beings, especially invalids, congregate, there the purity of the air is likely to be impaired."

That there is germ-life in the air of Denver and of towns in Colorado I am assured. Urine decomposes nearly as readily in these places as in Boston,

and if one wishes to be sure that the casts are not eaten up by little vibrioles, he must make his microscopic investigation early, just as he would in the East. Moreover, I have seen dead cattle lying on dry ground in Colorado, at varying elevations, subject to the drying effect of the sun's rays, which would desiccate, shrink up, and fall to pieces; and I have seen other dead cattle, at equal elevations, lying where there was some moisture, from which a most noisome stench would emanate. Certainly we do have decomposition at all elevations in Colorado, and that means putrefaction and, consequently, germ-life.

Where there is an absence of putrefaction in our climate, it seems to be due to the dryness of the air rather than the absence of germ-life. But even admitting the presence of germs, it does not militate against the purity of the Colorado air, for whatever qualities belong to mountain air certainly can be found in the air of our Rocky Mountains, whose sides are studded with towns up to an elevation of 11,000 feet, and whose summits tower into the skies at 14,000 feet,

It has often been said that different animals seem to possess different degrees of sensitiveness to the rare air of mountainous regions, and that the cat cannot exist at great elevations. This assertion, with others, should be subject to modification, for I know of one cat that lived for ten years at an elevation of 11,000 feet, and in Leadville, 10,000 feet, they are not at all absent.

Résumé.—These, then, are the general character-

istics of the Colorado climate: (1) elevation; (2) dry air; (3) a large amount of sunshine; (4) a warm sun temperature; (5) a somewhat variable temperature, cool, not cold, in winter—cold during a winter's night but comfortable at mid-day; (6) a moderate motion of the air, with occasional high winds; (7) a small snow- and rain-fall; (8) the absence of fogs; (9) a pure air; (10) a dry, sandy, well-drained soil.

But the simple narration of these climatic conditions in no way rounds out a just description of the arrest of consumption as applied in the Colorado climate. It does not tell of the local conditions of the different resorts; of the out-of-door life; of the diet and exercise; of the home life; of ranch life; in fact, of the various local conditions and of the means adopted to aid recovery, many of them varying from those employed elsewhere.

A description of this side of the subject furnishes too large a field to be handled by me at the present time, and in their individual application to the various cases of consumption they should be left entirely in the hands of a competent physician residing in that climate. One feature cannot be too strongly emphasized as characteristic of the Colorado cure. It is an all-year-round resort and not simply a winter resort, and, further, our State is an active, growing community, and there is plenty of room for the energies of the most active, when once a recovery is secured, so that a return to old methods and haunts is not to be recommended.

The State now claims a population of over 350,000 inhabitants. How many of these have come for

reasons of health it would be difficult to say. Every town and every city has its large percentage of such people, who, in their persons and in the energy of their lives, are the strongest testimony that can be given to the efficacy of the Colorado climate in the arrest and cure of pulmonary disease.

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